

three inches = one foot
one and one half inches = one foot
one inch = one foot
three quarters inch = one foot
one half inch = one foot
one quarter inch = one foot
one eighth inch = one foot

SEQUENCE OF OPERATION

GENERAL:

- 1. ALL CONTROLS SYSTEMS SHALL BE COMPLETE AND OPERATIONAL AT THE CONCLUSION OF THE CONSTRUCTION PROJECT.
- 2. IN A VISIBLE LOCATION ON HVAC EQUIPMENT UNDER DIRECT DIGITAL CONTROLLER (DDC) CONTROL, MOUNT A LAMINATED PLATE INSCRIBED WITH THE FOLLOWING: "CAUTION: THIS EQUIPMENT IS UNDER CENTRAL CONTROL AND MAY START OR STOP SUDDENLY. CONTACT PUBLIC WORKS BEFORE PERFORMING ANY MAINTENANCE OR DISCONNECTING ANY COMPONENTS."
- 3. DDC CONTROLLERS SHALL UTILIZE SHORT CYCLING DELAYS TO PROTECT NON-MODULATING TYPE EQUIPMENT SUCH AS FANS, PUMPS, COMPRESSORS, ETC. FROM SHORT CYCLING.
- 4. TERMINAL CONTROL UNITS (TCUS) SHALL BE STAND-ALONE PROGRAMMABLE AND SHALL BE SELECTED WITH THE APPROPRIATE NUMBER OF INPUTS AND OUTPUTS AS REQUIRED BY THE UNITS SEQUENCE OF OPERATION AND THE I/O SCHEDULE.
- 5. ALL CONTROL AND INTERLOCK WIRING SHALL BE SUPPLIED AND INSTALLED IN ACCORDANCE WITH THE SUPPLIED UNITS MANUFACTURERS RECOMMENDATIONS.
- 6. DURING THE OCCUPIED MODE, THE SPACE TEMPERATURE IS SETTING 75°F IN SUMMER AND 70°F IN WINTER. DURING THE UNOCCUPIED MODE, THE COOLING MODE STARTS WHEN THE SPACE TEMPERATURE IS HIGHER THAN 85°F, AND THE HEATING MODE STARTS WHEN THE SPACE TEMPERATURE IS LOWER THAN 65°F.

VAV BOXES

GENERAL:

- 1. A VAV BOX DAMPER SHALL BE CONTROLLED BY ITS TERMINAL CONTROL UNIT (TCU) BASED ON A TIMED OCCUPANCY AS SCHEDULED FOR THE SPACE IT SERVES.
- 2. A WALL MOUNTED SPACE TEMPERATURE SENSOR SHALL CONTROL ROOM CONDITIONS THROUGH THE TCU AND ENABLE THE ROOM OCCUPANTS TO VARY THE SPACE SETPOINT OVER A LIMITED RANGE AS DETERMINED BY THE DDC.
- 3. THE SPACE TEMPERATURE SENSOR SHALL DISPLAY TEMPERATURE SETPOINT AND SPACE TEMPERATURE.
- 4. THE SPACE TEMPERATURE SENSOR SHALL PROVIDE A TIMED OVERRIDE SCHEDULE THROUGH AN ON/OFF BUTTON.
- 5. COORDINATE THE FACTORY MOUNTING AND WIRING OF THE DDC CONTROLS WITH THE VAV BOX MANUFACTURER.

OCCUPIED MODE:

- 1. IN SUMMER THE TCU SHALL MODULATE THE VAV BOX SUPPLY AIR DAMPER TO MAINTAIN THE SPACE SETPOINT OF 75°F (ADJUSTABLE). ON A DROP IN SPACE TEMPERATURE, THE TCU SHALL MODULATE THE VAV BOX DAMPER TO ITS MINIMUM POSITION (ADJUSTABLE). ON A CONTINUED DROP IN SPACE TEMPERATURE, THE HOT WATER REHEAT COIL SHALL BE ENABLED TO SATISFY SPACE TEMPERATURE.
- 2. FOR ZONES WITH CO2 SENSORS (WAITING AREAS), CO2 CONTROL SHALL DETERMINE THE MINIMUM POSITION OF THE VAV BOX DAMPER AND ZONES AIR QUANTITIES. REHEAT COILS SHALL BE ENABLED TO MAINTAIN SPACE TEMPERATURES. WHERE ZONE CO2 CONTROL HAS DETERMINED THAT OCCUPANT DENSITY HAS DECREASED BASED ON 700 PPM DECREASING AND TEMPERATURES DROPPING, THE TERMINAL BOX DAMPERS SHALL MODULATE TOWARDS THE MINIMUM POSITION. THE SEQUENCE SHALL BE REPEATED EVERY 15 MINUTES AS REQUIRED. TYPICAL BOX AIR VOLUME MINIMUMS SHALL BE 30% OF MAXIMUM SCHEDULED WHEN CO2 AND TEMPERATURES ARE SATISFIED.
- 3. IN WINTER THE TCU SHALL POSITION THE SUPPLY AIR DAMPER TO ALLOW A MINIMUM FLOW OR TO ALLOW THE DESIGN HEATING AIRFLOW, OPEN THE 2-WAY CONTROL VALVE ON THE REHEATING COIL (IF THE VAV HAS A REHEAT COIL), AND ACTIVATE THE HOT WATER SYSTEM THROUGH THE DDC TO MAINTAIN THE SPACE SETPOINT OF 70°F (ADJUSTABLE). ON A DROP IN SPACE TEMPERATURE.

UNOCCUPIED MODE:

- 1. IN THE UNOCCUPIED MODE, THE BUILDING DDC SHALL INSTRUCT THE VAV BOX'S TCU TO CLOSE THE SUPPLY AIR DAMPER OF THE VAV BOX.
- 2. HOWEVER, IF A SPACE TEMPERATURE IS HIGHER THAN 85°F IN SUMMER, OR LOWER THAN 65°F IN WINTER, THE BUILDING DDC SYSTEM SHALL INSTRUCT THE VAV BOX'S TCU TO OPEN SUPPLY AIR DAMPER, CALL AHU TO CYCLE ITS SUPPLY FAN, AND START THE COOLING MODE IN THE SUMMER OR THE HEATING MODE IN WINTER TO MAINTAIN THE SPACE TEMPERATURE NO HIGHER THAN 85°F IN SUMMER, OR NO LOWER THAN 65°F IN WINTER.

SMOKE MODE:

- 1. THE BUILDING DDC SHALL INSTRUCT THE VAV BOX'S TCU TO CLOSE THE SUPPLY AIR DAMPER OF THE VAV BOX WHEN SMOKE IS DETECTED AND FIRE ALARM SYSTEM IS ACTIVATED.

ENERGY RECOVERY UNIT (ERU-1 AND ERU-2):

- 1. TWO ENERGY RECOVERY UNITS ERU-1 AND ERU-2 SHALL PROVIDE VENTILATION INTO THE SPACE IN MEETING THE ASHREA 62.1 AIR QUALITY REQUIREMENT. ERU-1 SERVES AHU-1 AND ERU-2 SERVES AHU-2. THE BUILDING DDC SHALL OPERATE THE ERUS BASED ON TIME OF DAY SCHEDULE IN SEQUENCE WITH AIR HANDLING UNITS.
- 2. DURING THE OCCUPIED MODE, THE SUPPLY AND EXHAUST FANS SHALL RUN CONTINUOUSLY, OUTDOOR AIR DAMPER SHALL OPEN FULLY, AND THE ENERGY RECOVERY WHEEL SHALL ROTATE. DURING THE UNOCCUPIED MODE, FANS SHALL DE-ENERGIZED, OUTDOOR AIR DAMPER SHALL CLOSE.
- 3. SMOKE DETECTORS SHALL STOP ENERGY RECOVERY UNIT FANS, CLOSE THE OUTSIDE AIR DAMPER AND DE-ENERGIZE THE UNIT UPON DETECTION OF PRODUCT OF COMBUSTION. AN ALARM CONDITION WILL BE PROVIDED TO THE FIRE ALARM PANEL UPON SUCH OCCURRENCE.
- 4. AIRFLOW MONITORING STATION LOCATED IN THE OUTSIDE AIR SECTION SHALL MEASURE VENTILATION AIRFLOW. ALARM SHALL BE SENT TO THE BMS IF VENTILATION RATE CHANGES 15% (ADJ) ABOVE OR BELOW MINIMUM CFM IN OCCUPIED MODE.
- 5. THE DDC SHALL MONITOR THE STATIC PRESSURE SENSORS LOCATED IN EACH THE OUTSIDE AIR SUPPLY DUCTWORK AND RELIEF AIR DUCTWORK RISERS TO MAINTAIN A MINIMUM SET POINT (0.75"ADJ.). THE ASSOCIATED FANS SHALL MODULATE AS REQUIRED THROUGH THE VFD BASED UPON THIS SYSTEM PRESSURE AS SPACE DAMPERS OPEN AND CLOSE.
- 6. WHENEVER THE BAS ENABLES THE ERU FAN SYSTEM, THE ENERGY WHEEL MOTOR SHALL ALSO BE ENABLED TO RUN AT A CONSTANT SPEED.
- 7. FOR ENERGY RECOVERY WHEEL, SUPPLY FAN AND EXHAUST FAN, ALARMS WILL BE PROVIDED FOR TWO CONDITIONS BELOW:
5.1 A FAILURE FOR WHEEL ROTATION/SUPPLY FAN/EXHAUST FAN OCCURS SO COMMANDED ON, BUT THE STATUS IS OFF.
5.2 WHEEL/SUPPLY FAN/EXHAUST FAN IS IN HAND, BUT COMMANDED OFF WHILE THE STATUS IS ON.

AIR HANDLING UNITS (AHU-1 AND AHU-2):

- 1. THERE ARE TWO AHUS (AHU-1 AND AHU-2). BOTH SHALL BE VARIABLE AIR VOLUME AND SHALL SUPPLY CONDITIONED AIR TO THE SPACES. THE AIR AT AN AHU HAS TWO SOURCES: THE OUTSIDE AIR PRECONDITIONED BY AN ENERGY RECOVERY UNIT AND THE RETURN AIR BACK FROM THE SPACE SERVED. BOTH OUTSIDE AIR AND THE RETURN AIR ARE MONITORED THROUGH AIR MEASURING STATIONS LOCATED IN DUCTWORKS.
- 2. THE QUANTITY OF OUTSIDE AIR REQUIRED SHALL BE DETERMINED FROM CONTROL SIGNALS FROM A CO2 SENSOR LOCATED IN THE RETURN AIR MAIN DUCTWORK, MODULATING BETWEEN THE MINIMUM AND MAXIMUM SCHEDULED OUTSIDE AIR QUANTITIES FOR THE SYSTEM.
- 3. FIXED EXHAUST AIR QUANTITIES FROM RESTROOMS AND THE REQUIRED AMOUNTS OF SPACE RELIEF AIR SHALL BE COMBINED INTO COMMON DUCTS DIRECTED INTO ENERGY RECOVERY UNITS LOCATED IN MECHANICAL ROOMS (B39 AND D23). RELIEF AIR QUANTITIES SHALL BE BASED ON MAINTAINING THE FIXED AIR QUANTITY DELTA SET POINTS BETWEEN THE OUTSIDE AIR MEASURING STATIONS AND THE RELIEF DUCT AIR MEASURING STATIONS FOR BUILDING PRESSURIZATION.
- 4. ALL ACTUATORS AND MOTORS FOR CONTROL DAMPERS AND CONTROL VALVES UNDER THE BUILDING DDC CONTROL SHALL PROVIDE VERIFICATION TO THE CENTRAL CONTROL WORKSTATION OPERATOR OF THE ACTUAL EQUIPMENT STATUS AND VALVE/DAMPER POSITIONS.
- 5. AN AHU SHALL BE ENABLED FROM THE DDC BASED ON OWNER TIME OF DAY SCHEDULE, FOR DEHUMIDIFICATION PURPOSES AND TO PROTECT BUILDING MATERIALS, ALL UNITS SHALL BE ENABLED TO OPERATE 24 HOURS WITH TEMPERATURE RESET AS SPECIFIED.
- 6. THE RETURN AIR DAMPER THAT IS FACTORY INSTALLED MOTORIZED OPPOSED BLADE AIR DAMPER SHALL MODULATE BASED ON MAINTAINING THE RELIEF AIR REQUIREMENTS. THE TESTING, ADJUSTING AND BALANCING FIRM SHALL SET THE REQUIRED AIR QUANTITY DIFFERENTIAL FOR THE AHU SYSTEM.
- 7. THE AIR FILTERS DIFFERENTIAL PRESSURE SHALL BE MONITORED TO NOT EXCEED A SET POINT OF 0.75" (ADJ.) PRESSURE DROP. AN ALARM SHALL BE SENT WHEN THIS IS EXCEEDED.
- 8. THE ERU OUTSIDE AIR DAMPER SHALL BE A FULLY ADJUSTABLE MODULATING ELECTRONIC ACTUATED NORMALLY CLOSED DAMPER. THE DAMPER SHALL OPEN WHEN THE AHU SUPPLY FAN IS ON AND CLOSED WHEN THE SUPPLY FAN IS OFF. THE ERU OUTSIDE AIR MONITORING STATION SHALL MODULATE THE ERU OUTSIDE DAMPER TO PROVIDE THE RANGE OF MINIMUM TO MAXIMUM AMOUNTS OF OUTSIDE AIR TO THE AHU AS SCHEDULED. THE AHU RETURN AIR CARBON DIOXIDE (CO2) LEVELS SHALL BE MONITORED AND THE AHU RETURN DAMPER MODULATED TO MAINTAIN SET POINT LEVELS AS SPECIFIED. TYPICAL CO2 SET POINT SHALL BE 700 PPM (ADJ.).

- 9. THE AHU RETURN AIR DAMPER SHALL BE A FULLY ADJUSTABLE ELECTRIC ACTUATED NORMALLY OPEN DAMPER. THE DAMPER SHALL BE CLOSED WHEN THE AHU SUPPLY FANS ARE OFF. UNDER NORMAL OPERATION, THE RETURN AIR DAMPER SHALL BE 100% OPEN. THE RETURN DAMPER POSITION SHALL BE ADJUSTED BY THE DDC TO PROVIDE RETURN AIR IN SEQUENCE WITH THE RELIEF AIR QUANTITIES.
- 10. AHUS SHALL BE CONTROLLED TO MAINTAIN A MAXIMUM SUPPLY AIR DUCT DISCHARGE TEMPERATURE OF 55°F (ADJUSTABLE) SET POINT BY CONTROLLING THE COOLING COIL TWO WAY CHILLED WATER VALVE. THE SUPPLY AIR FANS SHALL BE CONTROLLED BY DISCHARGE DUCT STATIC PRESSURE SET POINT OPTIMIZATION.
- 11. THE BUILDING DDC SHALL CONTINUOUSLY MONITOR THE DAMPER POSITION OF ALL VAV BOXES. THE DISCHARGE DUCT STATIC PRESSURE SHALL BE SENSED DIRECTLY AT THE DISCHARGE OF EACH AIR HANDLING UNIT. THE SENSOR MUST BE MOUNTED IN A NON-TURBULENT LOCATION.
- 12. WHEN ANY VAV TERMINAL DAMPER IS MORE THAN 75% (ADJ.) OPEN, THE SUPPLY FAN DISCHARGE DUCT STATIC PRESSURE SET POINT SHALL BE RESET UPWARD BY 0.1 IN. W.C.(ADJ.), AT A FREQUENCY OF 10 MINUTES (ADJ.), UNTIL NO DAMPER IS MORE THAN 75% OPEN OR THE STATIC PRESSURE SET POINT HAS RESET UPWARD TO THE SYSTEM MAXIMUM DUCT STATIC PRESSURE SET POINT (3.0') OR THE AIR HANDLING UNIT VARIABLE-FREQUENCY DRIVE IS AT THE MAXIMUM SPEED SETTING.
- 13. WHEN ALL VAV TERMINAL DAMPERS ARE LESS THAN 65% (ADJ.) OPEN, THE SUPPLY FAN DISCHARGE DUCT STATIC PRESSURE SET POINT SHALL BE RESET DOWNWARD BY 0.1 IN. W.C.(ADJ.), AT A FREQUENCY OF 10 MINUTES (ADJ.), UNTIL AT LEAST ONE DAMPER IS MORE THAN 65% OPEN OR THE STATIC PRESSURE SET POINT HAS RESET DOWNWARD TO THE SYSTEM MINIMUM DUCT STATIC PRESSURE SET POINT OR THE AHU VARIABLE-FREQUENCY DRIVE IS AT THE MINIMUM SPEED SETTING.
- 14. THE CONTROL BANDS, SET POINT INCREMENT VALUES, SET POINT DECREMENT VALUES AND ADJUSTMENT FREQUENCIES SHALL BE ADJUSTED TO MAINTAIN MAXIMUM STATIC PRESSURE OPTIMIZATION WITH STABLE SYSTEM CONTROL AND MAXIMUM COMFORT CONTROL.
- 15. THE DDC SHALL HAVE THE CAPABILITY TO ALLOW THE OPERATOR TO EXCLUDE ZONES THAT SHOULD NOT BE CONSIDERED WHEN DETERMINING THE OPTIMIZED SET POINT. THE DDC SHALL ALSO READ THE STATUS OF THE SUPPLY AIR STATIC PRESSURE SENSOR AND DISPLAY THE ACTIVE DUCT STATIC PRESSURE READING ON THE STATUS SCREEN.
- 16. THE BAS SHALL HAVE THE ABILITY TO IDENTIFY, AND DISPLAY TO THE USER, THE VAV BOX THAT SERVES THE CRITICAL ZONE (THAT IS, THE ZONE WITH THE MOST WIDE-OPEN VAV DAMPER). THIS INFORMATION SHALL UPDATE DYNAMICALLY AS THE LOCATION OF THE CRITICAL ZONE CHANGES BASED ON BUILDING LOAD, AND DUCT STATIC PRESSURE SET POINT OPTIMIZATION CONTROL.
- 17. DURING THE COMMISSIONING PROCESS, THE CONTROLS CONTRACTOR SHALL DEMONSTRATE THE PERFORMANCE OF FAN PRESSURE OPTIMIZATION
- 18. DUCT MOUNTED SMOKE DETECTORS IN THE SUPPLY AIR DUCT SHALL BE HARDWIRED TO THE FAN VFD TO STOP THE SUPPLY FANS WHEN SMOKE IS DETECTED AND CLOSE THE OUTSIDE AIR DAMPER. COORDINATE WITH THE FIRE ALARM CONTRACTOR TO STOP FAN ON ALARM.
- 19. THE AHU RETURN AIR DUCT CO2 SENSOR THROUGH THE DDC SHALL CONTROL THE OUTSIDE AIR DAMPER TO MAINTAIN MAXIMUM (700 PPM ADJUSTABLE) AND MINIMUM (400 PPM ADJUSTABLE) LEVELS. CO2 LEVELS EXCEEDING THE MAXIMUM SET POINT SHALL SEND AN ALARM.
- 20. THE ERU OUTSIDE AIR DAMPER SHALL MODULATE TO THE SCHEDULED MINIMUM AND MAXIMUM OUTSIDE AIR VOLUMES IN THIS SEQUENCE. AS THE AMOUNT OF OUTSIDE AIR INCREASES AND THE BUILDING PRESSURE INCREASES, THE ERU EXHAUST DUCT AIR DAMPER SHALL BE SEQUENCED TO MODULATE TOWARDS A FULLY OPEN POSITION AND THE AHU RETURN DAMPER TOWARDS A SMALLER OPENING POSITION. A FIXED AIR VOLUME DIFFERENTIAL, BETWEEN THE OUTSIDE AIR AND RELIEF AIR FOR EACH AHU, SET BY THE TAB FIRM SHALL MAINTAIN THE BUILDING PRESSURE SLIGHTLY POSITIVE.
- 21. WINTER NIGHT SETBACK MODE: THE DDC SHALL MAINTAIN AN UNOCCUPIED SPACE SETBACK TEMPERATURE, AS SENSED BY SPACE TEMPERATURE SENSORS OF THE PERIMETER VAV BOXES. THE DDC SHALL ENABLE AND SEQUENCE VAV BOXES ON, CLOSE THE PRIMARY AIR DAMPER, ENABLE THE HOT WATER HEATING COILS AS REQUIRED, TO MAINTAIN A BUILDING ZONE SET POINT TEMPERATURE OF 65°F (ADJUSTABLE). THE BOILERS AND RELATED CIRCULATING PUMPS SHALL BE ENABLED DURING THIS SEQUENCE. THE OUTSIDE AIR DAMPER SHALL BE CLOSED DURING THIS UNOCCUPIED MODE.
- 22. SUMMER NIGHT SETBACK MODE: THE DDC SHALL MAINTAIN AN UNOCCUPIED SPACE SETBACK TEMPERATURE, AS SENSED BY THE PERIMETER VAV SPACE SENSORS. THE DDC SHALL ENABLE THE WATER COOLED CHILLERS, COOLING TOWERS, RELATED WATER PUMPS AND AIR HANDLING UNITS AS REQUIRED, TO MAINTAIN A BUILDING ZONE SET POINT TEMPERATURE OF 85 DEGREES F. (ADJUSTABLE). ALL OUTSIDE AIR DAMPERS SHALL BE CLOSED IN THIS SEQUENCE.
- 23. WINTER MORNING WARM UP MODE: BASED ON TIME OF DAY SCHEDULING, ON MORNING START UP DURING THE UNOCCUPIED HOURS AND WHEN THE SPACE TEMPERATURE IS BELOW OCCUPIED SET POINT, THE DDC SHALL ENABLE THE FAN TERMINAL UNITS HEATING SEQUENCE TO WARM THE BUILDING TO SET POINT TEMPERATURE. ONCE SET POINT IS REACHED, THE SYSTEM SHALL RETURN TO NORMAL OPERATION. THE OUTSIDE AIR DAMPER SHALL BE CLOSED DURING THIS UNOCCUPIED MODE.
- 24. SUMMER MORNING COOL DOWN MODE: BASED ON TIME OF DAY SCHEDULING, ON MORNING START UP DURING THE UNOCCUPIED MODE AND WHEN THE SPACE TEMPERATURE IS ABOVE OCCUPIED SET POINT, THE DDC SHALL START THE AIR HANDLING UNITS. THE BAS SHALL ENABLE THE WATER COOLED CHILLERS, COOLING TOWERS AND RELATED PUMPS. THE OUTSIDE AIR DAMPERS SHALL BE CLOSED DURING MORNING COOL DOWN. ONCE SET POINT IS REACHED, THE SYSTEM SHALL RETURN TO NORMAL OPERATION. THE OUTSIDE AIR DAMPER SHALL BE CLOSED DURING THIS UNOCCUPIED MODE.

THE CHILLED WATER SYSTEM (CH-1, CHWP-1, AND CHWP-2)

GENERAL:

- 1. THE CHILLED WATER SYSTEM CONSISTS OF ONE AIR-COOLED CHILLER (CH-1), AND TWO CHILLED WATER PUMPS (CHWP-1 AND CHWP-2). CHWP-1 AND CHWP-2 ARE SIZED TO PROVIDE A 100% CAPACITY OF BUILDING COOLING LOAD AND OPERATE CONTINUOUSLY. THE OTHER PUMP IS AS STANDBY.
- 2. THE CHILLED WATER SYSTEM WILL SERVE AHU COOLING COILS. THE CHILLED WATER SUPPLY TEMPERATURE IS 45°F, AND THE CHILLED WATER RETURN TEMPERATURE IS ABOUT 55°F.
- 3. TWO CHILLED WATER PUMPS ARE PIPED IN PARALLEL. ONE PUMP CAN BE CONSIDERED AS A LEAD PUMP AND THE OTHER IS A LAG PUMP. EACH IS EQUIPPED A VFD TO PROVIDE AN ENERGY SAVING DURING OPERATION.
- 4. CH-1 IS LOCATED THE OUTSIDE OF MECHANICAL ROOM D23. THE TWO CHILLED WATER PUMPS ARE LOCATED INSIDE OF MECHANICAL ROOM D23.

SYSTEM OPERATION:

- 1. THE AIR-COOLED CHILLER (CH-1) SHALL BE STARTED AND STOPPED BY THE FACTORY CONTROL PANEL. THE CHILLER SHALL OPERATE THROUGH THE BUILDING DDC TO MAINTAIN A 45°F WATER SUPPLY TEMPERATURE FOR THE BUILDING.
- 2. THE DDC CONTROLLER SHALL ENERGIZE THE CHILLER AND THE LEAD CHILLED WATER PUMP WHEN THE OUTSIDE AIR TEMPERATURE HIGHER THAN 85°F (ADJUSTABLE) AND ANY AHU CALLS FOR COOLING.
- 3. THE DDC SYSTEM CONTROLLER SHALL ROTATE THE LEAD CHILLED WATER PUMP, ON A RUNTIME BASIS. SHOULD THE CHILLED WATER PUMP FAIL TO START WHEN COMMANDED, OR SHOULD IT STOP AFTER IT WAS RUNNING, AN ALARM S SOUND AT THE CENTRAL CONTROL WORKSTATION AND THE LAG (STAND-BY) PUMP SHALL BE ENERGIZED.
- 4. WHENEVER A PUMP FAILS, AS PROVEN BY VFD FAIL MODE OUTPUT, DIFFERENTIAL PRESSURE, OR LOSS OF FLOW, TH STANDBY SECONDARY PUMP SHALL START. THE FAILED PUMP SHALL BE DE-ENERGIZED, AND AN ALARM SHALL BE ANNUNCIATED AT THE CENTRAL CONTROL WORKSTATION.
- 5. CHILLED WATER DIFFERENTIAL PRESSURE SENSORS SHALL MODULATE THE PUMP VARIABLE FREQUENCY DRIVES TO MA THE SYSTEM PRESSURE. PROVIDE ONE DIFFERENTIAL PRESSURE SENSOR NEAR THE END OF CHILLED WATER DISTRIBUTION PIPING.
- 6. PUMP SPEED SHALL MODULATE BETWEEN THE MINIMUM SPEED (25% OR 15 HZ) AND THE MAXIMUM SPEED (93% OR HZ) TO MAINTAIN CONSTANT DIFFERENTIAL PRESSURE (18 FT, 7.8 PSI) AT ONE DIFFERENTIAL PRESSURE TRANSMITTER LOCATED IN SUPPLY AND RETURN LINES NEAR END OF SYSTEM.
- 7. THE FINAL MAXIMUM SPEED AND THE PRESSURE SETPOINT ARE TO BE DETERMINED BY THE TAB CONTRACTOR.

FAILURE MODE:

- 1. ON LOSS OF SIGNAL OR TRANSMITTER FAILURE, THE AIR-COOLED CHILLED SHALL BE CONTROLLED AT THE LAST OPERATING CONDITIONS (TEMPERATURE AND FLOW), AND ANY PUMP SHALL BE CONTROLLED AT THE LAST KNOWN SPEED AND THE BUILDING DDC SHALL ANNUNCIATE AN ALARM.
- 2. THE DDC SHALL ANNUNCIATE A GENERAL ALARM AT THE CENTRAL CONTROL WORKSTATION FOR ANY OF THE FOLLOWING SITUATIONS:
VFD FAULT FOR ANY PUMP;
CHILLED WATER SUPPLY TEMPERATURE IS ±5 OF SETPOINT FOR FIVE CONSECUTIVE MINUTES;
DIFFERENTIAL PRESSURE SENSOR IS ± 2 PSI OF SETPOINT FOR 5 CONSECUTIVE MINUTES;
FLOW SENSOR INDICATES THE FLOW IS LESS THAN MINIMUM FLOW SETPOINT FOR 2 CONSECUTIVE MINUTES.

THE HOT WATER SYSTEM (B-1, B-2, HWP-1 AND HWP-2)

GENERAL:

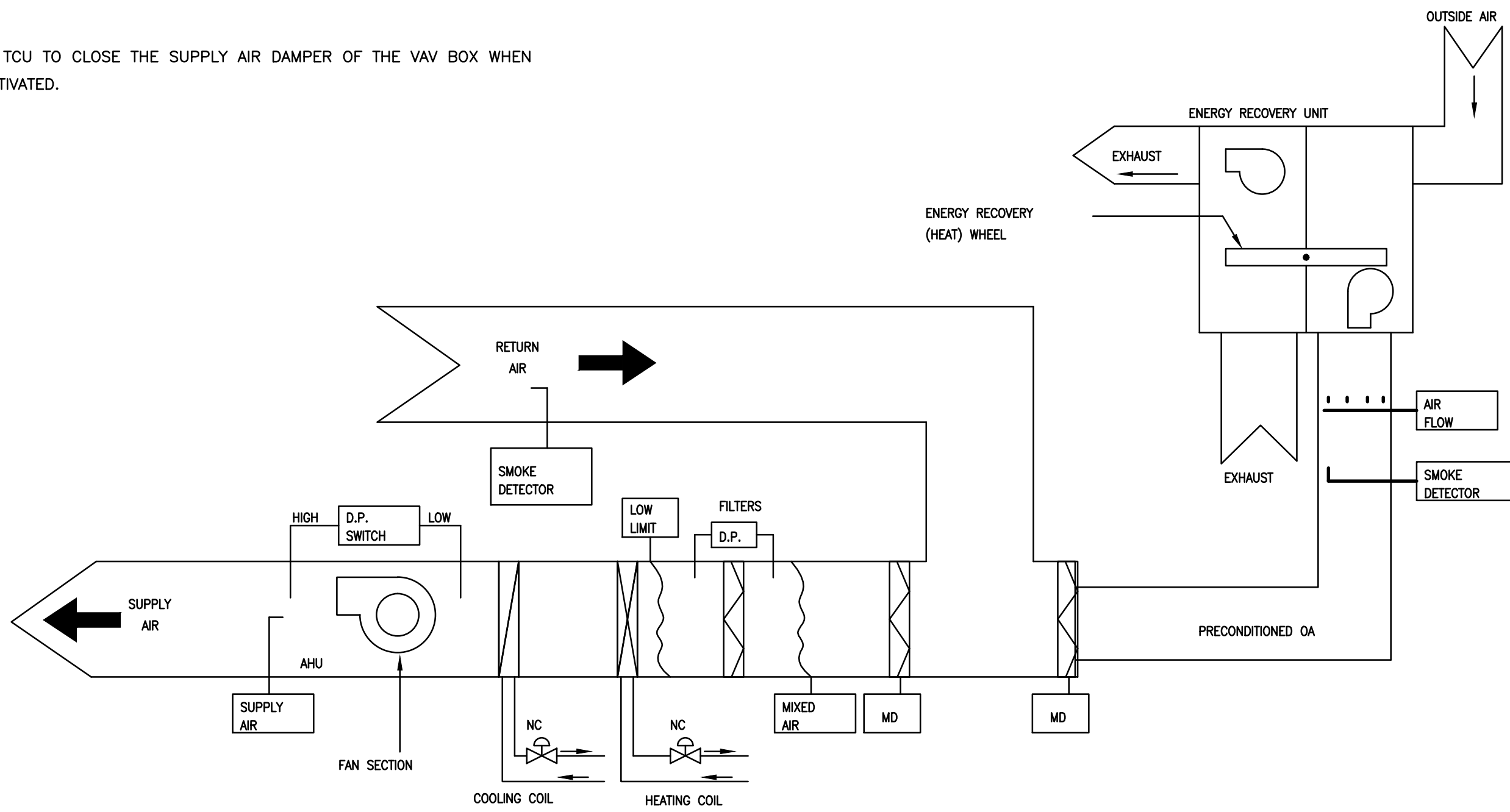
- 1. THE HOT WATER SYSTEM CONSISTS OF TWO BOILERS (B-1 AND B-2), AND TWO HOT WATER PUMPS (HWP-1 AND HWP-2). THE BOILERS AND PUMPS ARE SIZED TO PROVIDE A 100% CAPACITY OF BUILDING HEATING LOAD AND OPERATE CONTINUOUSLY. THE OTHER BOILER OR PUMP IS AS STANDBY. BOILERS AND HOT WATER PUMPS ARE LOCATED IN MECHANICAL ROOM D23.
- 2. THE HOT WATER SYSTEM WILL SERVE AHU PREHEATING COILS AND VAV BOX'S REHEATING COILS.
- 3. TWO BOILERS ARE PIPED IN PARALLEL. TWO PUMPS ARE ALSO PIPED IN PARALLEL. ONE BOILER AND ONE PUMP CAN BE CONSIDERED AS LEAD BOILER AND LEAD PUMP. THE OTHER BOILER AND PUMP ARE LAG BOILER AND LAG PUMP.
- 4. HOT WATER SUPPLY TEMPERATURE IS 150°F, AND HOT WATER RETURN TEMPERATURE IS EXPECTED TO BE 120 °F.
- 5. THE BUILDING DDC SHALL ENABLE AND DISABLE ANY OF BOILERS AND HOT WATER PUMPS BASED ON THE OWNER'S SCHEDULE OR REQUEST.

SYSTEM OPERATION:

- 1. BOILERS (B-1 AND B-2) SHALL BE STARTED AND STOPPED BY THE FACTORY BOILER CONTROL PANEL.
- 2. THE DDC CONTROLLER SHALL ENERGIZE THE LEAD BOILER AND THE LEAD HOT WATER PUMP WHEN THE OUTSIDE AIR TEMPERATURE DROPS TO 65°F (ADJUSTABLE) AND THE AHUS OR VAV BOXES CALL FOR HEATING.
- 3. THE DDC SYSTEM CONTROLLER SHALL ROTATE THE LEAD BOILER, AND THE LEAD HOT WATER PUMP, ON A RUNTIME BASIS.
- 4. SHOULD THE LEAD BOILER OR THE LEAD HOT WATER PUMP FAIL TO START WHEN COMMANDED, OR SHOULD IT STOP WHILE IT WAS RUNNING, AN ALARM SHALL SOUND AT THE CONTROL WORKSTATION AND THE LAG (STAND-BY) BOILER OR LA PUMP SHALL BE ENERGIZED.
- 5. HOT WATER DIFFERENTIAL PRESSURE SENSORS SHALL MODULATE THE PUMP VARIABLE FREQUENCY DRIVES TO MAINTAIN THE SYSTEM PRESSURE. PROVIDE TWO REMOTE DIFFERENTIAL PRESSURE SENSORS, ONE MAJOR HOT WATER PIPING DISTRIBUTION BRANCH EACH.
- 6. PUMP SPEED SHALL MODULATE BETWEEN THE MINIMUM SPEED (25% OR 15 HZ) AND THE MAXIMUM SPEED (93% OR HZ) TO MAINTAIN CONSTANT DIFFERENTIAL PRESSURE (18 FT, 7.8 PSI) AT ONE DIFFERENTIAL PRESSURE TRANSMITTER LOCATED IN SUPPLY AND RETURN LINES NEAR END OF SYSTEM.
- 7. THE FINAL MAXIMUM SPEED AND THE PRESSURE SETPOINT ARE TO BE DETERMINED BY THE TAB CONTRACTOR.

FAILURE MODE:

- 1. ON LOSS OF SIGNAL OR TRANSMITTER FAILURE, A BOILER SHALL BE CONTROLLED AT THE LAST OPERATING CONDITION, AND A PUMP SHALL BE CONTROLLED AT THE LAST KNOWN SPEED AND THE BUILDING DDC SHALL ANNUNCIATE AN ALARM.
- 2. THE DDC SHALL ANNUNCIATE A GENERAL ALARM AT THE CONTROL WORKSTATION FOR ANY OF THE FOLLOWING SITUATIONS:
VFD FAULT FOR EACH PUMP;
HEATING WATER SUPPLY TEMPERATURE IS ±5 OF SETPOINT FOR FIVE CONSECUTIVE MINUTES;
DIFFERENTIAL PRESSURE SENSOR IS ± 2 PSI OF SETPOINT FOR 5 CONSECUTIVE MINUTES;
FLOW SENSOR INDICATES THE FLOW IS LESS THAN MINIMUM FLOW SETPOINT FOR 2 CONSECUTIVE MINUTES.



TYPICAL AHU WITH ERU (AHU-1/ERU-1 AND AHU-2/ERU-2)

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